

What is claimed is:

1. A method of foaming a well fluid comprising the steps of:
providing a foamable well fluid;
providing compressed air with an oxygen content less than an amount necessary to support combustion of hydrocarbons; and
foaming the fluid with the reduced oxygen content compressed air.
2. The method of claim 1 wherein the compressed air has less than about 12.5% oxygen content by volume.
3. The method of claim 1 wherein the compressed air has less than about 5% oxygen content by volume.
4. The method of claim 1 wherein the step of preparing the compressed air comprises contacting the air with an oxygen scavenger prior to or after compressing the air.
5. The method of claim 4 wherein the oxygen scavenger is selected from the group consisting of sodium thiosulfate, sodium sulfite, sodium bi-sulfite, pyrogallol, catechal, sodium erythrobate, ascorbic acid, amines, resorcinol, quinones and hydroquinones and mixtures thereof.
6. The method of claim 1 wherein the foamed fluid comprises from about 20% to about 80% reduced oxygen content air by volume.
7. The method of claim 1 wherein the foamed fluid comprises from about 20% to about 60% reduced oxygen content air by volume.
8. The method of claim 1 wherein the fluid comprises a mixture of foaming and foam stabilization surfactants present in the range of from about 0.5% to about 5% by volume of water in the fluid.

Rule 126 ⁸ 10. The method of claim 9 wherein the mixture of foaming and foam stabilization surfactants are present in the range of from about 1% to about 2.5% by volume of water in the fluid.

11 11. The method of claim 1 wherein the fluid comprises a mixture of foaming and foam stabilization surfactants comprising an alpha-olefinic sulfonate and a cocoylamidopropyl betaine.

11 12. The method of claim 1 wherein the fluid comprises a mixture of foaming and foam stabilization surfactants comprising an ethoxylated alcohol ether sulfate of the formula $H(CH_2)_a(OC_2H_4)_bOSO_3NH_4^+$ wherein "a" is an integer in the range of from about 6 to about 10 and "b" is an integer in the range of from about 3 to about 10, an alkyl or alkene amidopropylbetaine having the formula $R--CONHCH_2CH_2CH_2N^+(CH_3)_2CH_2CO_2^-$ wherein R is a radical selected from the group consisting of decyl, cocoyl, lauryl, cetyl and oleyl and an alkyl or alkene amidopropyldimethylamineoxide having the formula $R'--CONHCH_2CH_2CH_2N^+(CH_3)_2O^-$ wherein R' is a radical selected from the group consisting of decyl, cocoyl, lauryl, cetyl and oleyl.

11 13. The method of claim 12 wherein the ethoxylated alcohol ether sulfate is present in an amount ranging from about 60 to about 64 parts by weight, the alkyl or alkene amidopropylbetaine is present in an amount ranging from about 30 to about 33 parts by weight and the alkyl or alkene amidopropyldimethylamineoxide is present in an amount ranging from about 3 to about 10 parts by weight of the mixture of foaming and foam stabilization surfactants.

11 14. The method of claim 1 wherein the well fluid is selected from the group consisting of drilling fluids, completion fluids, and stimulation fluids.

11 15. The method of claim 1 wherein the well fluid is selected from the group consisting of drilling muds, well cleanup fluids, workover fluids, spacer fluids, gravel pack fluids, acidizing fluids, and fracturing fluids.

11 16. The method of claim 1 further comprising the step of placing the resulting foamed fluid into a subterranean zone.

Rule 126 ¹⁶
~~17.~~ The method of claim 1 further comprising the step of drilling, completing and/or stimulating a subterranean formation using the foamed fluid.

" ¹⁷
~~18.~~ The method of claim 1 further comprising the step of producing a fluid from the subterranean formation.

" ¹⁶ ¹⁷
~~19.~~ The method of claim ~~18~~ wherein the fluid produced from the formation is oil and/or gas.

" ¹⁹
~~20.~~ A foamed well composition comprising:
a well fluid; and
air having an oxygen content less than an amount required to support combustion of hydrocarbons present in an amount sufficient to foam the fluid.

" ²⁰
~~21.~~ The composition of claim ¹⁹~~20~~ wherein the air has less than about 12.5% oxygen content by volume.

" ²¹
~~22.~~ The composition of claim ¹⁹~~20~~ wherein the air has less than about 5% oxygen content by volume.

" ²²
~~23.~~ The composition of claim ¹⁹~~20~~ wherein the air is prepared using an oxygen scavenger.

" ²⁷ ²²
~~24.~~ The composition of claim ~~23~~ wherein the oxygen scavenger is selected from the group consisting of sodium thiosulfate, sodium sulfite, sodium bi-sulfite, pyrogallol, catechol, sodium erythrobate, ascorbic acid, amines, resorcinol, quinones and hydroquinones and mixtures thereof.

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~~25.~~ The composition of claim ¹⁹~~20~~ wherein the foamed fluid comprises from about 20% to about 80% reduced oxygen content air by volume.

" ²⁵ ¹⁹
~~26.~~ The composition of claim ~~20~~ wherein the foamed fluid comprises from about 20% to about 60% reduced oxygen content air by volume.

Rule 126 ²⁶
~~27.~~ The composition of claim ¹⁹~~20~~ wherein the fluid comprises a mixture of foaming and foam stabilization surfactants present in the range of from about 0.5% to about 5% by volume of water in the fluid.

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~~28.~~ The composition of claim ²⁶~~27~~ wherein the mixture of foaming and foam stabilization surfactants are present in the range of from about 1% to about 2.5% by volume of water in the fluid.

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~~29.~~ The composition of claim ¹⁹~~20~~ wherein the fluid comprises a mixture of foaming and foam stabilization surfactants comprising an alpha-olefinic sulfonate and a cocoylamidopropyl betaine.

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~~30.~~ The composition of claim ¹⁹~~20~~ wherein the fluid comprises a mixture of foaming and foam stabilization surfactants comprising an ethoxylated alcohol ether sulfate of the formula $H(CH_2)_a(OC_2H_4)_bOSO_3NH_4^+$ wherein "a" is an integer in the range of from about 6 to about 10 and "b" is an integer in the range of from about 3 to about 10, an alkyl or alkene amidopropylbetaine having the formula $R--CONHCH_2CH_2CH_2N^+(CH_3)_2CH_2CO_2^-$ wherein R is a radical selected from the group consisting of decyl, cocoyl, lauryl, cetyl and oleyl and an alkyl or alkene amidopropyldimethylamineoxide having the formula $R'--CONHCH_2CH_2CH_2N^+(CH_3)_2O^-$ wherein R' is a radical selected from the group consisting of decyl, cocoyl, lauryl, cetyl and oleyl.

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~~31.~~ The method of claim ²⁹~~30~~ wherein the ethoxylated alcohol ether sulfate is present in an amount ranging from about 60 to about 64 parts by weight, the alkyl or alkene amidopropylbetaine is present in an amount ranging from about 30 to about 33 parts by weight and the alkyl or alkene amidopropyldimethylamineoxide is present in an amount ranging from about 3 to about 10 parts by weight of the mixture of foaming and foam stabilization surfactants.

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~~32.~~ The composition of claim ¹⁹~~20~~ wherein the well fluid is selected from the group consisting of drilling fluids, completion fluids, and stimulation fluids.

Rule 26 ³² 33. The composition of claim ¹⁹ 28 wherein the well fluid is selected from the group consisting of drilling muds, well cleanup fluids, workover fluids, spacer fluids, gravel pack fluids, acidizing fluids, and fracturing fluids.

" ³³ 34. A foamed well composition comprising:
a well fluid selected from the group consisting of drilling fluids, completion fluids, and stimulation fluids; and
air having less than about 12.5% oxygen content by volume present in an amount sufficient to foam the fluid.

" ³⁴ 35. The composition of claim ³³ 34 wherein the air is prepared using an oxygen scavenger.

" ³⁵ 36. The composition of claim ³⁴ 35 wherein the oxygen scavenger is selected from the group consisting of sodium thiosulfate, sodium sulfite, sodium bi-sulfite, pyrogallol, pyrogallol, catechol, sodium erythrobate, ascorbic acid, amines, resorcinol, quinones and hydroquinones and mixtures thereof.

" ³⁶ 37. The composition of claim ³³ 34 wherein the air is present in an amount from about 20% to about 80% by volume.

" ³⁷ 38. The composition of claim ³³ 34 wherein the fluid comprises a mixture foaming and foam stabilization surfactants.

" ³⁸ 39. The composition of claim ³⁷ 38 wherein the foaming and foam stabilization surfactants are present in the range of from about 0.5% to about 5% by volume of water in the fluid.

" ³⁹ 40. The composition of claim ³⁷ 38 wherein the mixture of foaming and foam stabilization surfactants comprises an alpha-olefinic sulfonate and a cocoamidopropyl betaine.

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41. The composition of claim 38 wherein the mixture of foaming and foam stabilization surfactants comprises an ethoxylated alcohol ether sulfate of the formula $H(CH_2)_a(OC_2H_4)_bOSO_3NH_4^+$ wherein "a" is an integer in the range of from about 6 to about 10 and "b" is an integer in the range of from about 3 to about 10, an alkyl or alkene amidopropylbetaine having the formula $R--CONHCH_2CH_2CH_2N^+(CH_3)_2CH_2CO_2^-$ wherein R is a radical selected from the group consisting of decyl, cocoyl, lauryl, cetyl and oleyl and an alkyl or alkene amidopropyldimethylamineoxide having the formula $R'--CONHCH_2CH_2CH_2N^+(CH_3)_2O^-$ wherein R' is a radical selected from the group consisting of decyl, cocoyl, lauryl, cetyl and oleyl.

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42. The composition of claim 41 wherein the ethoxylated alcohol ether sulfate is present in an amount ranging from about 60 to about 64 parts by weight, the alkyl or alkene amidopropylbetaine is present in an amount ranging from about 30 to about 33 parts by weight and the alkyl or alkene amidopropyldimethylamineoxide is present in an amount ranging from about 3 to about 10 parts by weight of the mixture of foaming and foam stabilization surfactants.

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43. The composition of claim 34 wherein the well fluid is selected from the group consisting of drilling muds, well cleanup fluids, workover fluids, spacer fluids, gravel pack fluids, acidizing fluids, and fracturing fluids.